

Amino Acids as a Source of Organic Nitrogen in Antarctic Endolithic Microbial Communities

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In the Antarctic Dry Valleys, cryptoendolithic microbial communities occur within porous sandstone rocks. Current understanding of the mechanisms of physiological adaptation of these communities to the harsh Antarctic environment is limited, because traditional methods of studying microbial physiology are very difficult to apply to organisms with extremely low levels of metabolic activity. In order to fully understand carbon and nitrogen cycling and nutrient uptake in cryptoendolithic communities, and the metabolic costs that the organisms incur in order to survive, it is necessary to employ molecular geochemical techniques such as amino acid analysis in addition to physiological methods. Low-molecular-weight biomolecules such as amino acids can be used as tracers of carbon and nitrogen uptake and loss by microbial communities living in solid-state matrices such as rock or sediment.

We have measured the concentrations and D/L ratios for several amino acids as a function of depth in a large sandstone boulder. Concentrations of both free and bound amino acids decrease by more than two orders of magnitude from the surface to the visible base of the community (approximately 1.2 cm depth), while the D/L ratios of the amino acids increase from near zero to 0.2 or greater over the same depth interval. We interpret these data as an indication that one or more community members are selectively scavenging L-amino acids as the amino acids are transported through the rock by intermittently percolating meltwater. This is consistent with the known preference of lichens for amino acids as nitrogen sources rather than inorganic nitrogen under conditions of nutrient limitation. It is not yet clear whether there is also a contribution to amino acid uptake from heterotrophic bacteria associated with the cryptoendolithic community. The increase in D/L ratios with depth observed in the rock is too great to be attributable solely to the natural occurrence of D-amino acids in bacteria.

Amino acid concentration and D/L profiles remain relatively constant below the 1.2 cm level. This may be due to aqueous transport from the upper levels. It is also possible, however, that heterotrophs at very low cell densities may exist several cm below the bottom of the bulk endolithic community.